Compatibility of the Expansive Nondecelerative Universe Model with the Newton Gravitational Theory and the General Theory of Relativity

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Abstract. Applying the Vaidya metrics in the model of Expansive Nondecelerative Universe (ENU) leads to compatibility of the ENU model both with the classic Newton gravitational theory and the general theory of relativity in weak fields.

Applying the Vaidya metrics [1] to gravitational field has led us [2] to relation

$$\varepsilon_g = -\frac{R.c^4}{8\pi.G} = -\frac{3m.c^2}{4\pi.a.r^2} \quad (1)$$

where ε_g is the density of the gravitational energy created by a body with the mass m in the distance r, R is the scalar curvature, a is the gauge factor reaching at the present

$$a \approx 10^{26} m \quad (2)$$

The mean energy density of ENU, ε_{ENU} is expressed [3] as

$$\varepsilon_{ENU} = \frac{3c^4}{8\pi.G.a^2} \quad (3)$$

When both densities are of the identical value

$$|\varepsilon_g| = \varepsilon_{ENU} \quad (4)$$

then the following relations hold

$$R = r_{ef} = (R_g.a)^{1/2} \quad (5)$$

in which r_{ef} is the effective radius of a body with the mass m, R_g is its gravitational diameter.

Compton wave λ_C can be expressed as

$$\lambda_C = \frac{\hbar}{m.c} \quad (6)$$

and then, based on identity of (5) and (6), relation expressing the lightest particle capable to have gravitational influence on its environment appears [3]

$$m_x^3 = \frac{\hbar^2}{2G.a} \quad (7)$$

The above mentioned relations are taken as starting points to manifest mutual compatibility of the Vaidya metrics incorporating ENU model and Newton gravitational theory.

In the Newtonian approach, relation describing the density of gravitational energy is usually written as follows [2]

$$\varepsilon_g = \frac{3G.m^2}{4\pi.r^4} \quad (8)$$

Providing that

$$\lambda_C = r \quad (9)$$

the identity of (3) and (8) leads to (7) which means that the ENU model, Vaidya metrics and Newton gravitational theory are mutually compatible.

Compatibility of the ENU model and the general theory of relativity will be exemplified on Hawking model of black hole evaporation [4]. It was Hawking who, stemming from principles of quantum mechanics, thermodynamics and cosmology, evidenced that the output P of quantum evaporation of a black hole with the diamater R_{BH} is

$$P = \frac{\hbar.c^2}{R_{BH}^2} \qquad (10)$$

and the energy E of a single quantum of the evaporation is

$$E = \frac{\hbar.c}{R_{BH}} \qquad (11)$$

The mass $m_{\lim}$ of a limiting black hole is given [2, 4] by relation

$$m_{\lim} = \left(\frac{\hbar.c^4.t}{4G^2}\right)^{1/3} \qquad (12)$$

where t is the cosmologic time. Comparing (11) and (12), for the energy of a limiting black hole evaporation quantum it follows

$$E = m_x.c^2 \qquad (13)$$

where

$$m_x = \left(\frac{\hbar^2}{2G.a}\right)^{1/3} \qquad (14)$$

i.e. identity of (7) and (13) is manifested.

The mentioned identity can be taken as an example documenting compatibility of the ENU model, Vaidya metrics and the general theory of relativity.

Conclusions

The present results document the justifiability of Vaidya metrics incorporation into mathematical tools used in cosmological problems solving;

The inclusion of Vaidya metrics in the ENU model allows to localize and quantify the energy of gravitational field outside a body;

The present contribution suggests the existence of unity of the ENU model, Newton gravitational theory and general theory of relativity.

References

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